Ultraviolet Cross-Linking of Temperature Sensative Pentablock Polymers

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Background: Polymers

A polymer is a large "chain" type molecule made up of many smaller molecules covalently bonded together. These chains can have hundreds of links combined together to form the single polymer molecule. In this particular molecule different sections of the chain are made up of the same type of link. Each section of similar links is called a block. A Pentablock polymer ($PDEAEM_{15}$) has five different sections. Each section may behave differently based on the environment that the polymer is placed in.

$PDEAEM_{15}$ is temperature sensitive. When cool the polymers can slide past one another, when warm the polymers knot together in clusters called micelle. Micelle are like a knot of spaghetti where the ends of each noodle are on the outside. When exposed to ultraviolet light micelle can cross-link, making the gel structure more permanent. This polymer must be cross linked in order to create a substance that does not break down as quickly.

Researchers hope this particular polymer has applications in repairing cartilage damage. When a person tears cartilage, a doctor could inject this polymer as a liquid into the tear. Then as the polymer warms it would create a gel the same consistency of cartilage. Then it would be exposed to UV light making the rate of decay of polymer the same as the growth of new cartilage.

Background: Chemical Engineer

A chemical engineer is a scientist who uses their understanding of Chemistry and Physics, along with Math to create new substances for application in a wide variety of fields.

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Purpose of Research

Gain a better understanding how polymers are cross linked using ultraviolet light

Determine the optimal distance and intensity required to crosslink a sample of $PDEAEM_{15}$-PEG_{1000} under high intensity ultraviolet light. PEG_{1000} is a smaller in size commercially available light sensitive polymer that will aid in the cross-linking of $PDEAEM_{15}$.

Calibrate the ultraviolet lamp.

METHODS

This experiment was set up by creating a solution of $PDEAEM_{15}$/PEG_{1000}.20% by weight. $PDEAEM_{15}$ is in a 5:1 ratio to the PEG_{1000}. This mixture of powders then has a photointiator (a substance that is reactive to light) added. When the final mixture is placed in a refrigerator overnight it becomes a liquid solution. The solution is then separated into individual vials containing ≈ 300mg of solution. This solution becomes more viscous at room temperature and is cooled to allow the sample to pool at the bottom of the vial. The sample is then set out for 10 minutes prior to exposure to ultraviolet light. high intensity lamp has been set up for us to attempt to duplicate previous results. A variety of heights and intensities were tested to initiate cross-linking of the polymer. Once exposed to UV light the sample is then placed under 2mL of deionized water. If cross-linking was successful the sample will swell and remain as a gel. If cross-linking was unsuccessful, the sample will dissolve into the water.

RESULTS

In our short time in the lab, we were able to identify parameters for samples of $PDEAEM_{15}$-PEG_{1000} 20%by weight to cross-link, using a low intensity light. However, we believe that the intensity of the high powered lamp damaged the polymer creating an environment that cross-linking was not possible. To date no samples have been cross-linked using the high-intensity lamp.

DISCUSSION

The work being done in this lab is fascinating. While our particular project was working on creating a synthetic cartilage, another group was working on using a similar polymer from the same family to deliver DNA to cancer cells, while still another group was using a polymer from the family to precipitate magnetic iron crystals.

This demonstrates the variety of applications a single family of polymers can have and the important role a chemical engineer serves in the advancement of science. The ability of these scientists to see so many applications for a compound is staggering.

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